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**Patentanmeldung Nr. Patent application No. Demande de brevet n°**

02080275.7

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Anmelder/Applicant(s)/Demandeur(s):

Koninklijke Philips Electronics N.V.  
Groenewoudseweg 1  
5621 BA Eindhoven  
PAYS-BAS

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Protective layer for optical recording media

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## Protective layer for optical recording media

The invention relates to an optical data storage medium for recording using a focused radiation beam having a wavelength  $\lambda$  and entering through an entrance face of the medium during recording, comprising at least a first substrate, a second substrate and a stack of layers, said stack comprising in this order:

- 5 - a first dielectric protective/interference (multi-)layer,
- a recording layer,
- a second dielectric protective/interference (multi-)layer,
- a heat-sink/reflective layer,

10 said stack being interposed between the first substrate and the second substrate and the first dielectric layer being present closest to the entrance face.

Phase-change optical recording is based on the media comprising a recording stack, which contains a recording layer of phase-change material. The state of the phase-change material can be converted from crystalline to amorphous in a reversible way. The transition between the states is achieved by heating the phase-change layer with a focused laser beam.

This process is known as initialization and involves heating the phase-change layer of the recording stack to the desired temperature for a certain period of time.

The currently applied recording stacks comprise a layer of phase-change material sandwiched between dielectric (multi)-layers, and a metal reflector/heat-sink layer.

20 The complete recording stack is disposed onto a substrate and covered with a cover layer. In Figure 1 an example is given of Blu-Ray Disc (BD)-type and Compact Disc (CD) / Digital Versatile Disc (DVD)-type media. The reference numerals are related to the medium design as follows:

25 In case of BD-type:

- 1 – disc substrate
- 2 – heat-sink/reflector layer
- 3 – second dielectric protective/interference (multi-)layer
- 4 – recording layer

5 – first dielectric protective/interference (multi-)layer

6 – cover layer

In case of CD/DVD-type:

- 5 1 – cover layer for CD or dummy substrate for DVD
- 2 – heat-sink/reflector layer
- 3 – second dielectric protective/interference (multi-)layer
- 4 – recording layer
- 5 – first dielectric protective/interference (multi-)layer
- 10 6 – disc substrate

The laser beam enters the media through the cover in the case of BD-type media and through the substrate in the case of CD/DVD-type media (in both cases indicated by numeral 6 in Fig. 1).

- 15 The purpose of the first dielectric layer (indicated by numeral 5 in Fig. 1) is two-fold:

- It serves for thermal protection of the cover layer (or the substrate in CD/DVD media)

- It serves for optimization of optical performance of the recording stack

- 20 Depending on the thickness of this layer reflection level of the stacks can be varied in a periodic way. The optical performance in this case depends on the thickness of the layer as  $d = (m \cdot \lambda) / (2 \cdot n)$ , where  $d$  is the layer thickness,  $n$  is the refractive layer of the layer material,  $\lambda$  is the wavelength applied, and  $m$  in an integer number. An example of such a periodic behavior is given in Fig. 2. If a stack with high-to-low signal polarity is used (*i.e.* a
- 25 stack were reflection of the crystalline state is higher than that of the amorphous state) the thickness of the first dielectric layer is chosen such that the amorphous reflection is close to its minimum. In this case high optical contrast between the amorphous state and the crystalline state (and thus high signal modulation) is achieved.

- 30 During disc initialization and optical recording, heat accumulation and heat transport take place in the media, particularly across the recording stack. From the thermal performance point of view if the first dielectric layer is absent or too thin, the temperatures reached at the interface between the stack and the substrate/cover can be too high for the substrate/cover material to withstand. As a result, damage to the media is caused. This damage results in deterioration of the signals and an increase in the media noise. Therefore, it

is favorable to have the first dielectric layer as thick as possible or in the sense of reflection minima to chose the thickness at a high-order minimum (see Fig. 3).

On the other hand, as have been mentioned above the optical performance of the stack depends on the thickness of the first dielectric layer. If normal incidence of a ray of the laser beam is considered, no optical difference is present if the thickness of the dielectric layer is chosen with the period of  $(m \cdot \lambda) / (2 \cdot n)$ , where  $m = 1, 2, 3$ , etc. However, in the real systems a converging laser beam is used. Also, the media normally has a grooved structure. It means that the majority of the rays in the beam face the stack at incidences other than normal. In this case the effective light-path through (i.e. the effective thickness of) the dielectric layer depends on the angle of incidence. This causes different phase shifts and as a result the optical performance of the stack is affected. Moreover, the thicker the dielectric layer the larger the phase shift and the bigger the deterioration of the optical performance performance. The optical performance of the stack depends on the incidence angle  $\alpha$  as  $1/\cos(\alpha)$ . If an angle of e.g. 35 degree is considered (what is an average angle in the converging laser beam of the BD system), the optical performance is affected by about 22%. Therefore, form the optical performance point of view it is favorable to have the first dielectric layer as thin as possible or in the sense of reflection minima to chose the thickness at the first minimum (see Fig. 3).

In the case of CD- and DVD-type media, the first amorphous reflection minimum occurs at relatively large (about 150-200 nm) thicknesses of the first dielectric layer which are sufficient for thermal protection of the substrate. In the case of BD-system, the typical thickness of the first dielectric layer is only about 40 nm. Eventually, for UV-recording the first dielectric layer will be even thinner.

In the present invention disclose it is proposed to apply a thermal barrier layer between the recording stack and the cover (substrate) which is made of material(s) with relatively low thermal conductivity to damp the heat flow and at the same time has a refraction index which the same as (or sufficiently close to) that of the cover (substrate) of the media. Such a layer would have no influence on the optical performance of the media while would carry out its thermal protection function. Furthermore, this layer can be a multi-layer structure. In this case the thickness of the first dielectric layer can be kept at the first minimum of the amorphous reflection.

In the case of BD-system, the wavelength is 405nm. The refractive index of the cover layer at this wavelength is 1.5. In this case SiO<sub>2</sub> can be used as a protective layer as proposed in the present invention disclosure since it has a refractive index of 1.5 and is a

good thermal insulator. To improve the performance of the media, a sufficiently thick layer of SiO<sub>2</sub> can be placed between the first dielectric layer (indicated by numeral 5 in Fig. 1) and the cover (indicated by numeral 6 in Fig. 1).

## CLAIM:

1. An optical data storage medium for recording using a focused radiation beam having a wavelength  $\lambda$  and entering through an entrance face of the medium during recording, comprising at least a first substrate, a second substrate and a stack of layers, said stack comprising in this order:

- 5 - a first dielectric protective/interference (multi-)layer,
- a recording layer,
- a second dielectric protective/interference (multi-)layer,
- a heat-sink/reflective layer,

10 said stack being interposed between the first substrate and the second substrate and the first dielectric layer being present closest to the entrance face,  
characterized in that a thermal barrier layer, transparent for the radiation beam, is present adjacent the first dielectric layer at the side of the entrance face.

## ABSTRACT:

An optical data storage medium for recording using a focused radiation beam having a wavelength  $\lambda$  is described. The beam enters through an entrance face of the medium during recording. The medium comprises at least a first substrate (1), a second substrate (6) and a stack of layers, said stack comprising in this order:

- 5       -           a first dielectric protective/interference (multi-)layer (5),
- a recording layer (4),
- a second dielectric protective/interference (multi-)layer (3),
- a heat-sink/reflective layer (2).

10       The said stack is interposed between the first substrate (1) and the second substrate (6). The first dielectric layer is present closest to the entrance face. A thermal barrier layer, transparent for the radiation beam, is present adjacent the first dielectric layer (5) at the side of the entrance face in order to prevent media noise.

Fig. 1



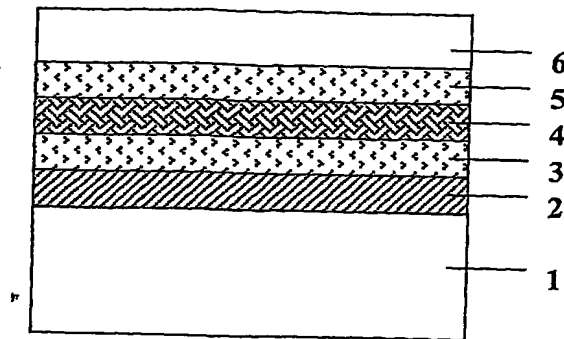


Fig. 1

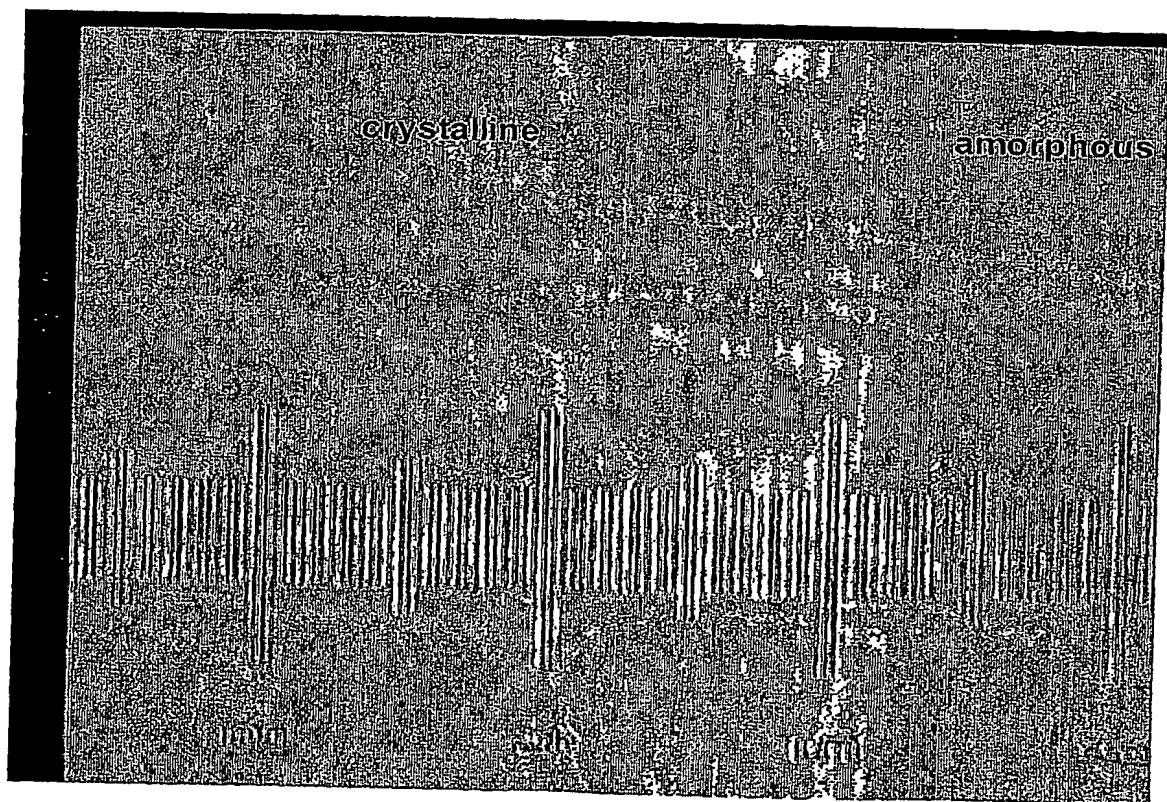
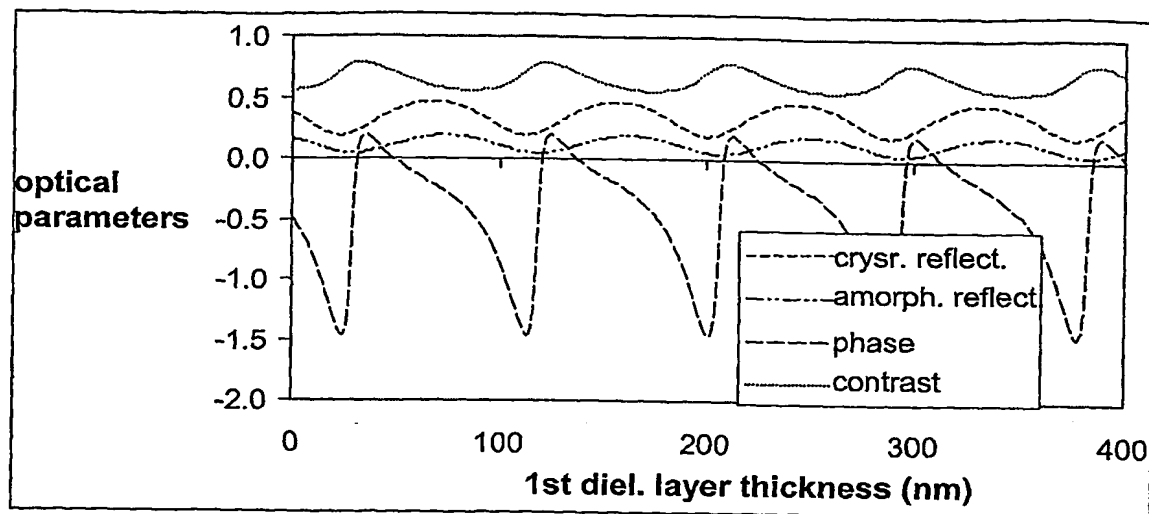


Fig. 2

**Fig. 3**

PCT Application  
**IB0350032**



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